A LOOK AT THE ARID WEST WATER QUALITY RESEARCH PROJECT

Western Coalition of Arid States

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San Diego, California
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PRESENTATION OUTLINE

- AWWQRP – Program recap
- AWWQRP – Regulatory impacts
  - *Metals criteria*
  - *Ephemeral streams*
- Where do we go from here?
  - *Big picture thoughts*
  - *Emerging issues*
    - Ephemeral waters and WOTUS
    - Salts criteria and regulations
- Key takeaway messages

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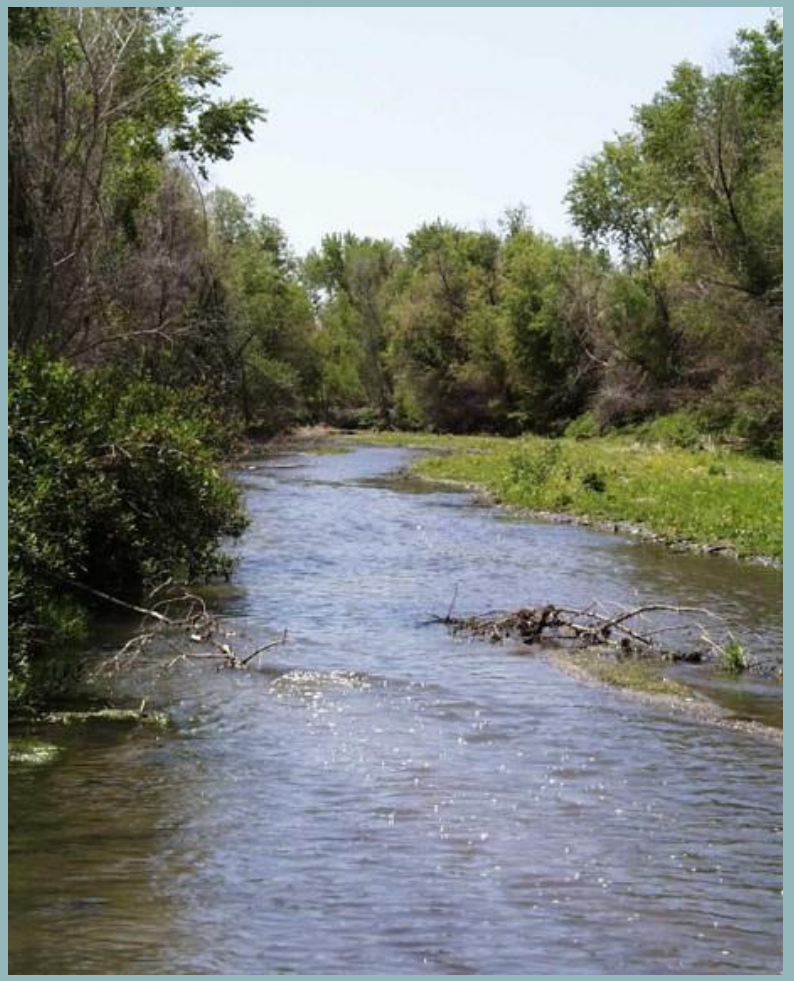
ARID WEST WATER QUALITY RESEARCH PROJECT

Program Recap

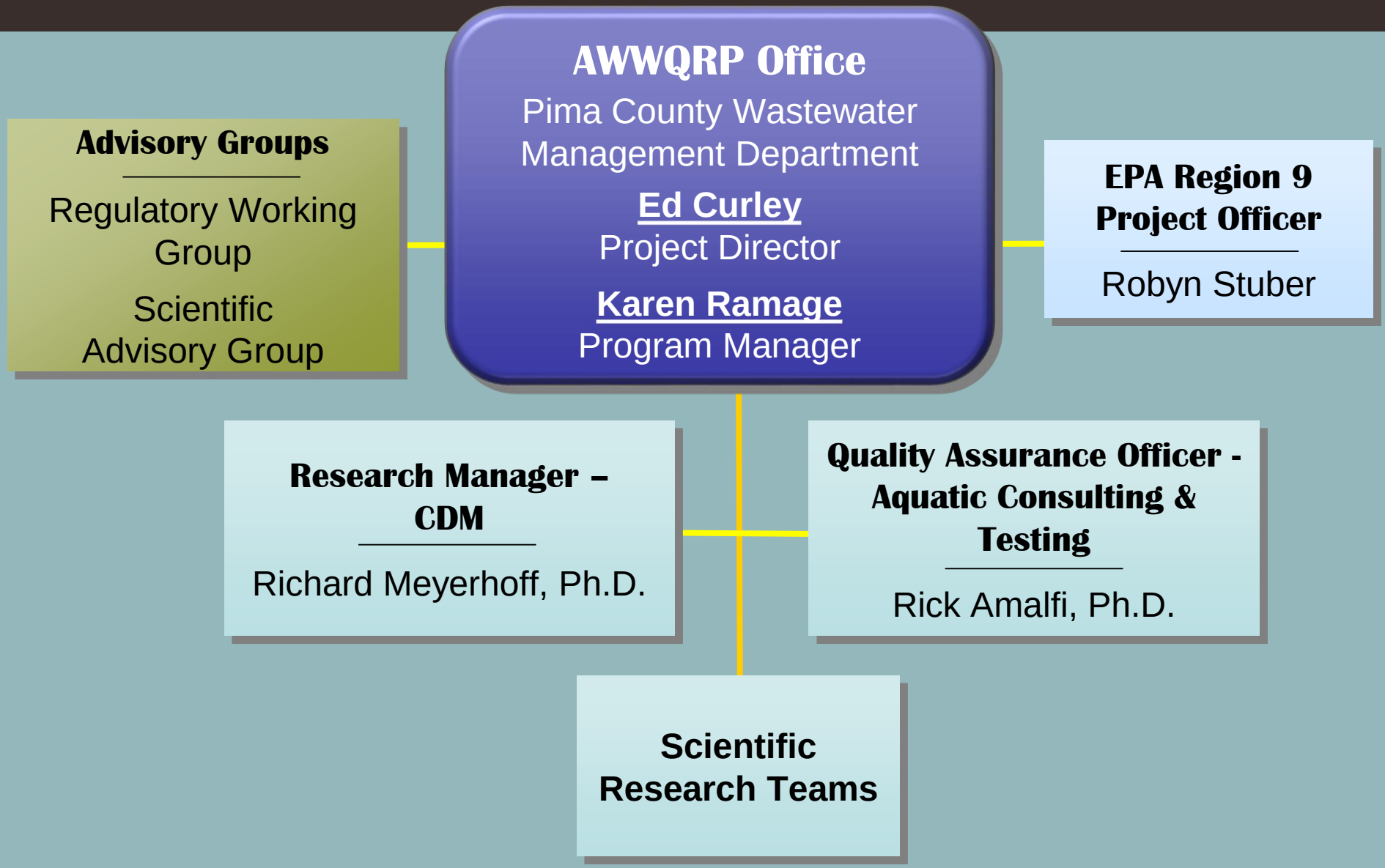
WATER QUALITY RESEARCH PROJECT
ARID WEST

PROJECT ORIGINS AND PURPOSE

- Established in 1995 through $5,000,000 federal appropriation and establishment of an Assistance Agreement between EPA and Pima County Wastewater Management Department
  - *Additional $500,000 authorized in 2001*
- *"Conduct scientific research and disseminate scientific information on western ephemeral and effluent-dependent waters to help resolve issues of significance to both the regulated community and regulators at state, tribal, and federal levels."*



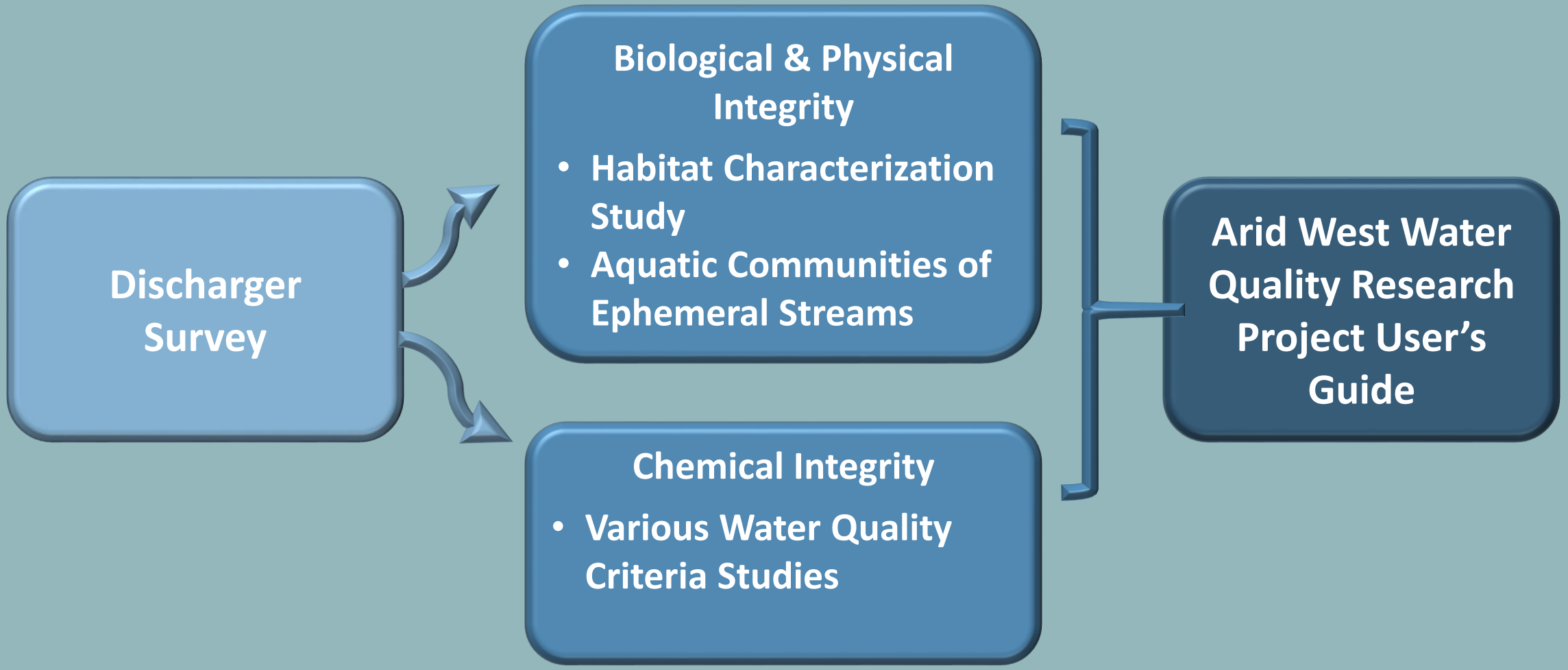
AWWQRP ORGANIZATION



AWWQRP RESEARCHERS

- Colorado State University,
- University of Arizona, Environmental Research Laboratory; School of Renewable Natural Resources
- U.S. Geological Survey, Tucson Desert Laboratory
- Aquatic Consulting and Testing, Inc.
- CDM (now CDM Smith)
- Chadwick Ecological Consulting, Inc. (now part of GEI Consultants)
- Ecotox
- ENSR International (now part of AECOM)
- Environmental Planning Group
- Hydroqual (now part of HDR)
- Parametrix
- Risk Sciences
- Tetra Tech (with Water Environment Research Foundation)
- URS Corporation (now part of AECOM)
- Law Offices of Tad Foster, Colorado Springs, CO

AWWQRP RESEARCH DELIVERABLES



AWWQRP RESEARCH DELIVERABLES

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Water Quality Criteria Studies

- Extant Criteria Evaluation
- Evaluation of the Reliability of Biotic Ligand Model (BLM) Predictions for Copper Toxicity in Waters Characteristic of the Arid West
- Evaluation of the EPA Recalculation Procedure in the Arid West and Preparation of the Recalculation Procedure User's Guide
- Hardness-Dependent Ammonia Toxicity and the Potential Use of the Water-Effect Ratio
- Special Studies:
  - Use of the EPA Recalculation Procedure with the Copper Biotic Ligand Model
  - Relative Role of Sodium and Alkalinity vs. Hardness in Controlling Acute Ammonia Toxicity

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Regulatory Impacts

WATER QUALITY RESEARCH PROJECT
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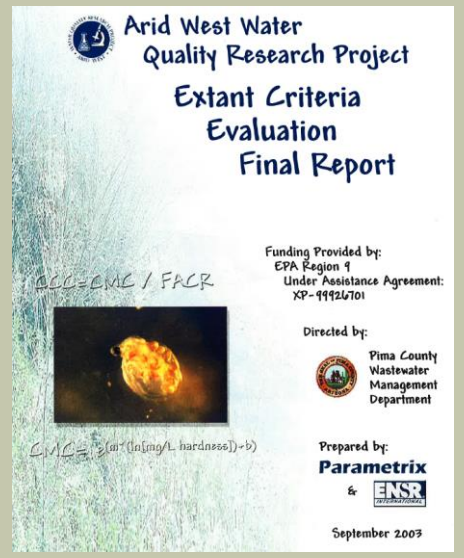
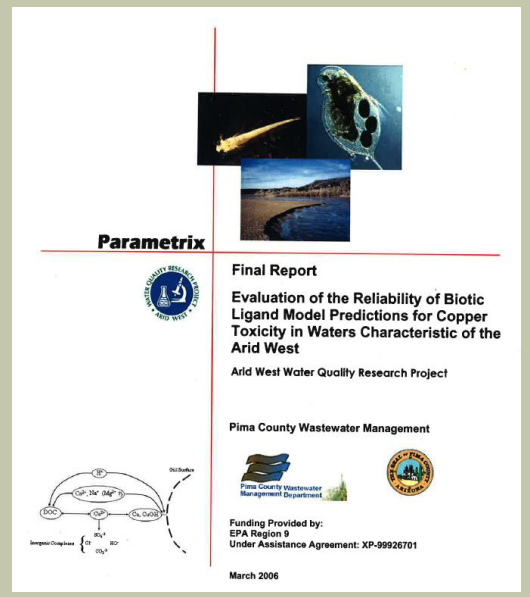
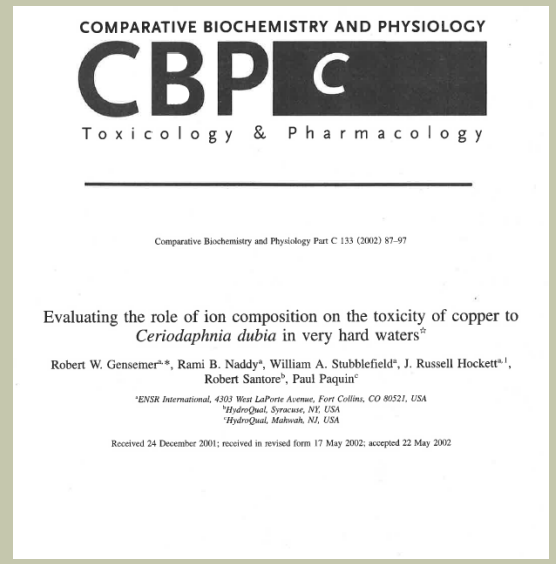
REGULATORY IMPACTS – COPPER CRITERIA

- AWWQRP projects:
  - *Extant Criteria Evaluation (2003)*
  - *Copper Biotic Ligand Model (BLM) Evaluation (2006)*
- Used in support of USEPA national AWQC (2007)
  - *Publications and presentations*
  - *Affirmed model application to hard waters*
- Used in BLM training courses





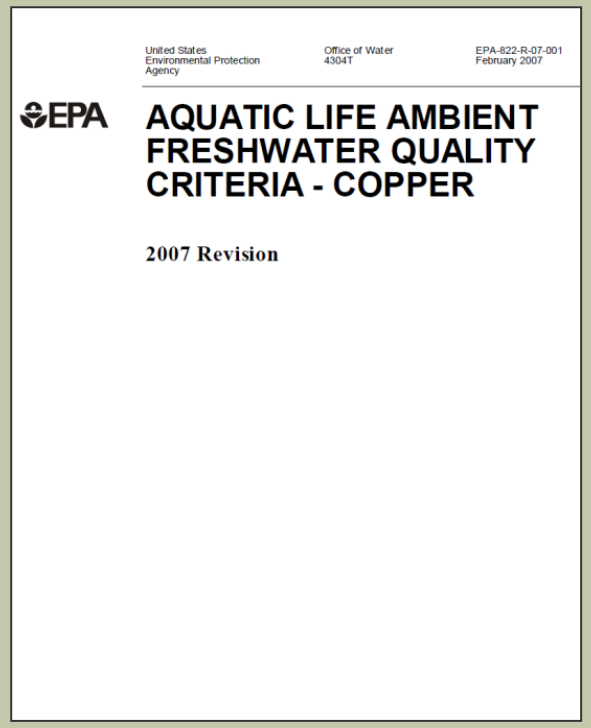


THE BIOTIC LIGAND MODEL (BLM): A BETTER SOLUTION

- EPA's nationally-recommended criteria (2007) includes the BLM
- Generates aquatic life criteria for Cu (acute and chronic) using 10 water quality input parameters:

  - *Temperature*
  - *pH*
  - *DOC **
  - *Calcium*
  - *Magnesium*
  - *Sodium*
  - *Potassium*
  - *Sulfate*
  - *Chloride*
  - *Alkalinity*

* DOC = dissolved organic carbon

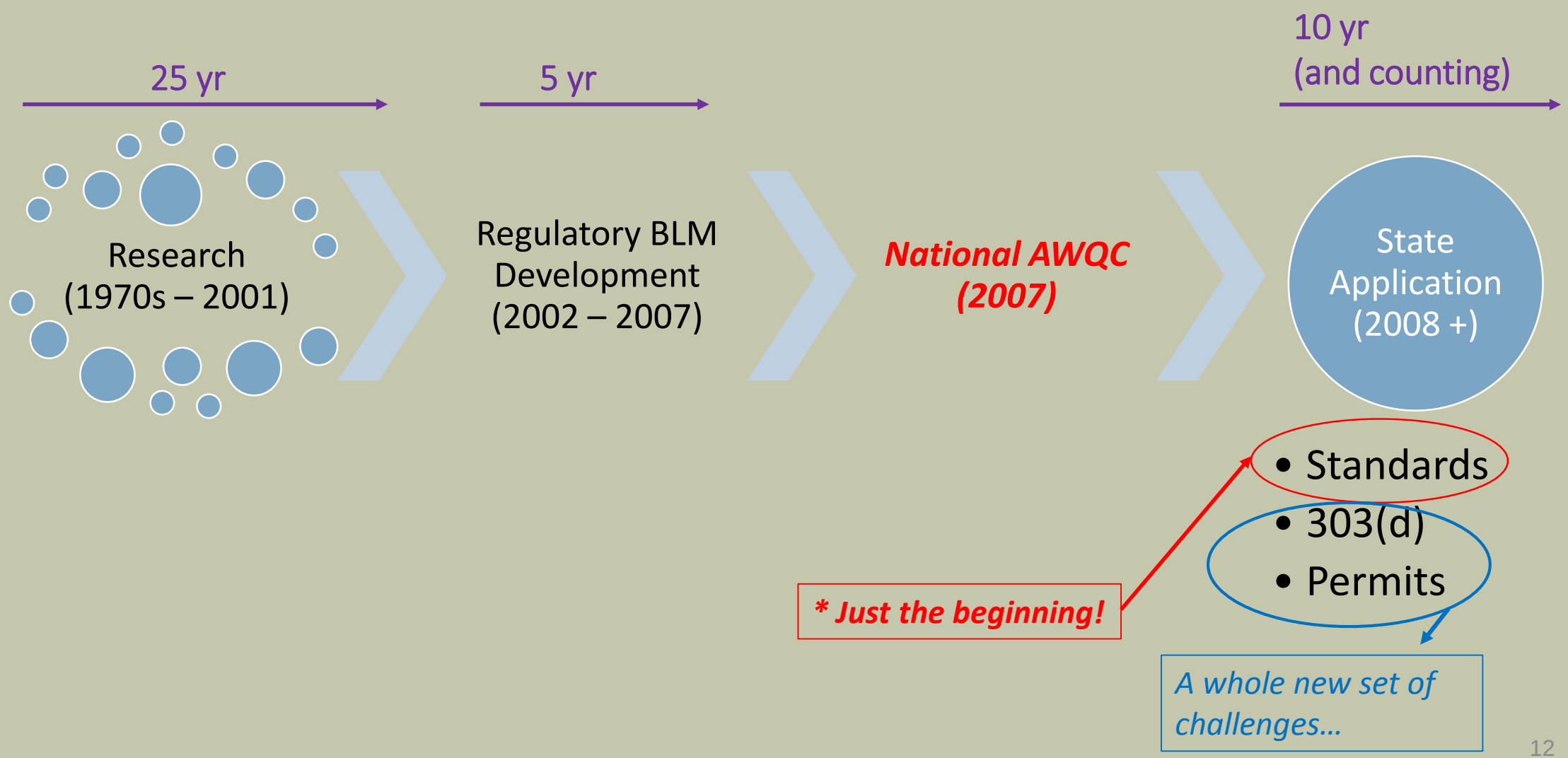

United States Environmental Protection Agency | Office of Water 4304T | EPA-822-R-07-001 February 2007

EPA

AQUATIC LIFE AMBIENT FRESHWATER QUALITY CRITERIA - COPPER

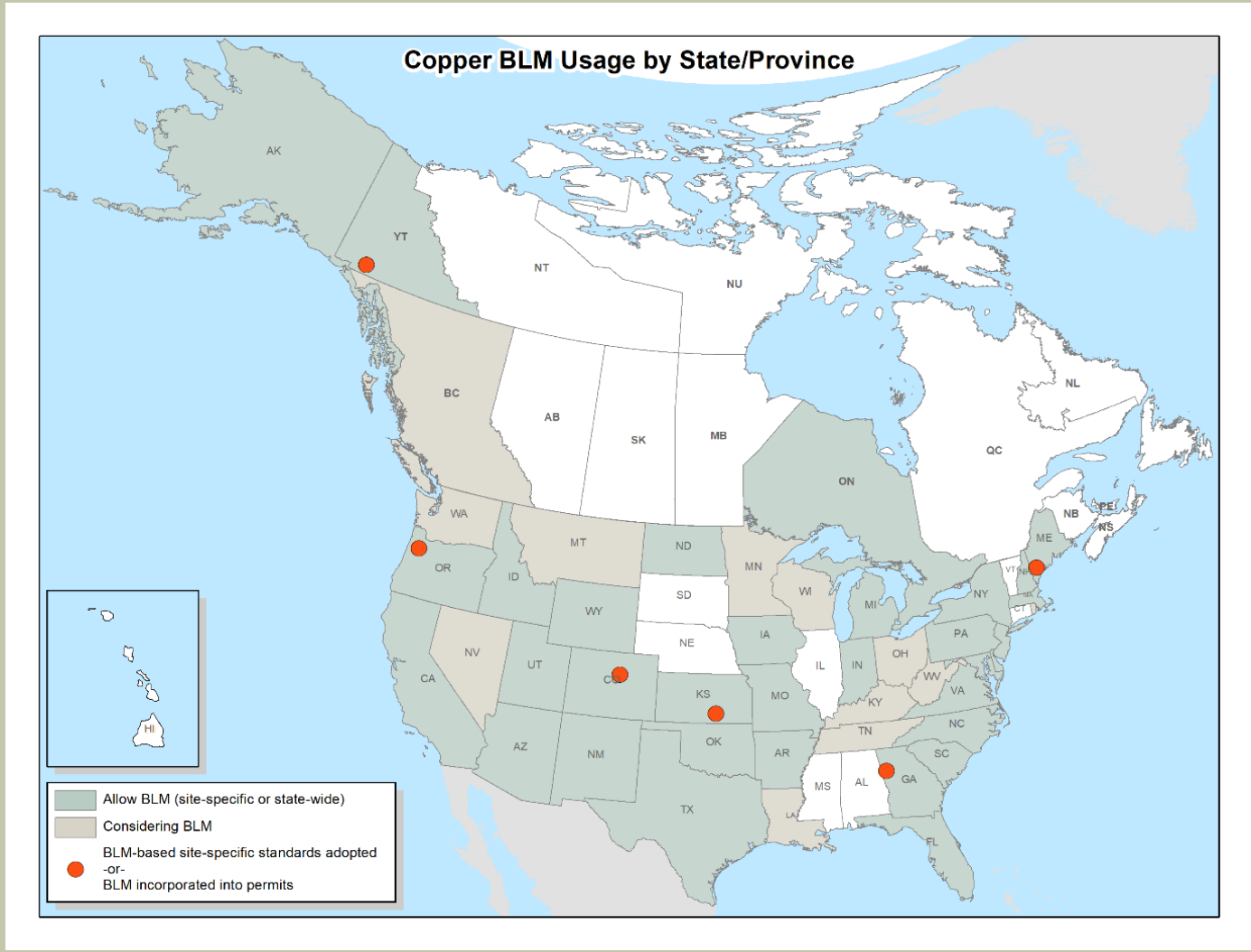
2007 Revision

APPLICATION OF THE COPPER BLM



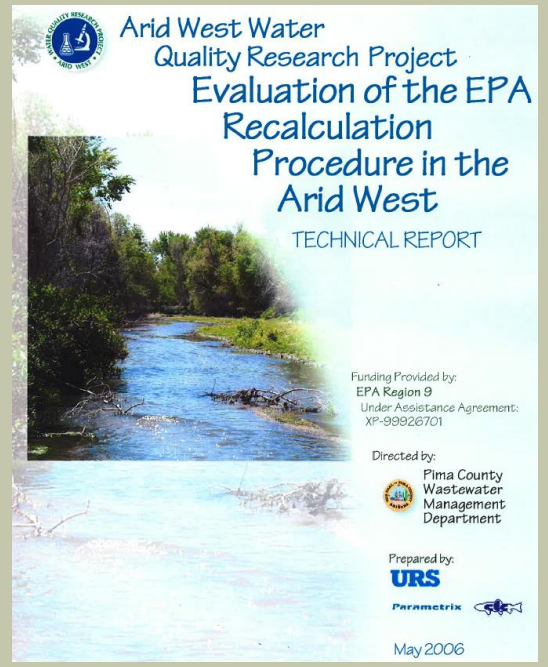
COPPER BLM: CURRENT STATUS

- Most states use BLM only for site-specific standards
- Only OR, KS, DE with true state-wide standards (ID soon)



REGULATORY IMPACTS – ALUMINUM CRITERIA

- Recalculation Procedure project (2006)
  - *Developed first-ever hardness-based AWQC*
  - *1988 National AWQC (87 & 750 ppb, chronic/acute) too conservative in all but very soft waters*
- Basis of New Mexico (2009) and Colorado (2010) water quality standards
  - *NMAC 20.6.4.900, acute & chronic*



(1) Acute aquatic life criteria for metals. The equation to calculate acute criteria in µg/L is $\exp(m_A[\ln(\text{hardness})] + b_A)(CF)$. Except for aluminum, the criteria are based on analysis of dissolved metal. For aluminum, the criteria are based on analysis of total recoverable aluminum in a sample that is filtered to minimize mineral phases as specified by the department. The equation parameters are as follows:

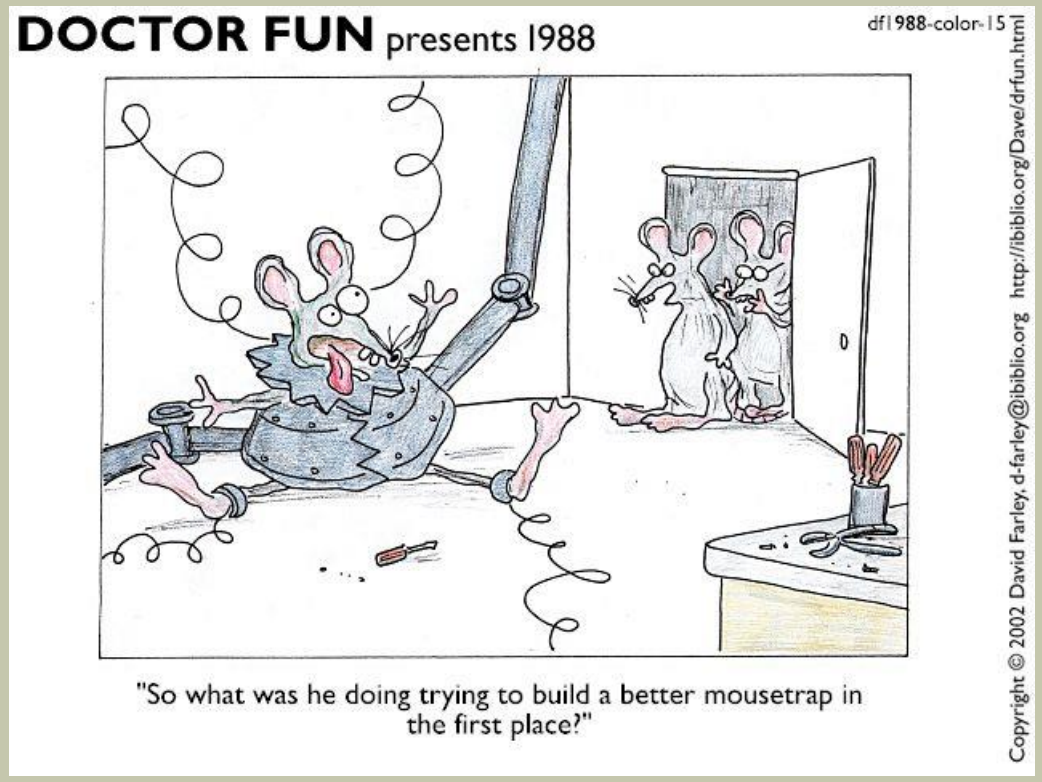
Metal	m_A	b_A	Conversion factor (CF)
Aluminum (Al)	1.3695	1.8308	
Cadmium (Cd)	0.8968	-3.5699	1.136672-[(ln hardness)(0.041838)]
Chromium (Cr) III	0.8190	3.7256	0.316
Copper (Cu)	0.9422	-1.700	0.960
Lead (Pb)	1.273	-1.460	1.46203-[(ln hardness)(0.145712)]
Manganese (Mn)	0.3331	6.4676	
Nickel (Ni)	0.8460	2.255	0.998
Silver (Ag)	1.72	-6.59	0.85
Zinc (Zn)	0.9094	0.9095	0.978

NEXT STEPS FOR ALUMINUM

- New science still in development; EPA draft AWQC in 2017
  - *Using simpler approach: Multiple Linear Regression (MLR) model*
  - *Based only on hardness, pH, and DOC*
- Analytical chemistry needs further development
  - *Total recoverable metals assays dissolve non-toxic mineral aluminum*
    - Particular problem in high TSS waters
    - Can cause significant false positives
  - *Solutions?*
    - Coarse pre-filtration (New Mexico – WQS)
    - pH 4 “bioavailable aluminum” extraction procedure (in development)

METALS CRITERIA AND THE ARID WEST

- AWWQRP research has helped develop and implement new aquatic life criteria for metals
- *Water quality matters!*
  - *Its not all about hardness—pH and DOC also important*
  - *Considering bioavailability (e.g., BLM) will benefit many in Arid West*
    - Elevated hardness
    - DOC in effluent-dependent waters
  - *Simpler models now available*
  - *Also need to account for TSS (e.g., aluminum, likely iron)*



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ARID WEST WATER QUALITY RESEARCH PROJECT

Aquatic Communities of Ephemeral Stream Ecosystems

WATER QUALITY RESEARCH PROJECT
ARID WEST

STUDY PURPOSE AND APPROACH

- Provide data regarding what biota need to be protected in ephemeral streams – ***Appears to still be one of the best references on the subject***
- Examined aquatic communities (macroinvertebrate, microinvertebrate, vertebrate) in watersheds of three distinct bioregions:
  - *High plains of eastern Colorado*
  - *Colorado Plateau of northern New Mexico and*
  - *Sonoran Desert of southern Arizona*
- Sample locations included:
  - *No upstream source of water (ephemeral streams)*
  - *Ephemeral segments of streams that were intermittent or perennial elsewhere in the watershed ("ephemeral reaches of interrupted streams")*

KEY FINDINGS

- Resident taxa list for the studied streams differs from:
  - *National database*
  - *Effluent-dominated/dependent stream database developed by the AWWQRP*
- Standards for ephemeral streams based on resident species likely to be quite different from national, state, and even site-specific standards for sites with perennial flow.
- Predominance of terrestrial, aerially dispersive types of insects suggests that ephemeral stream species lists need to be reflective of the watershed they drain

RECOMMENDATIONS

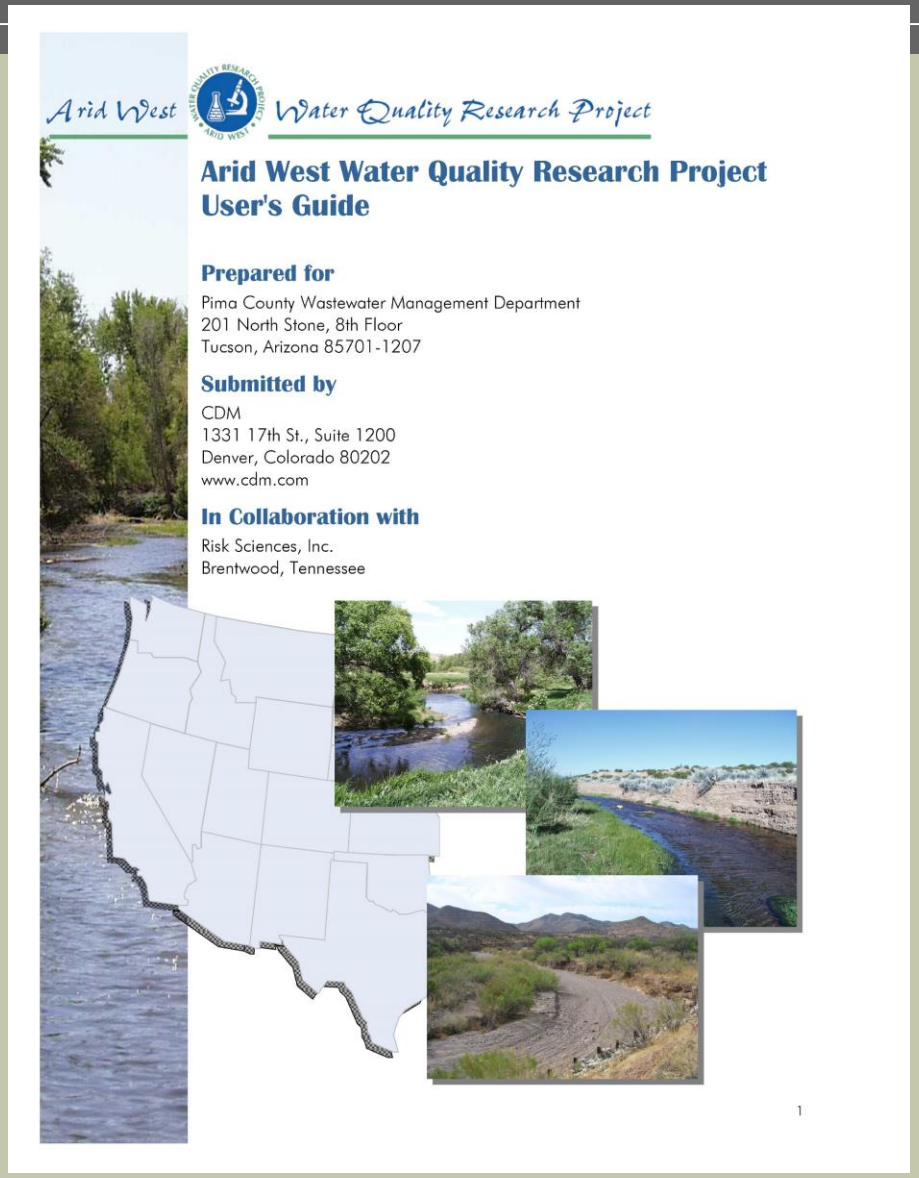
- Studies needed over multiple seasons and wider geographical area to take into account ecoregional distinctions
- More extensive study of watersheds needed for characterization of:
  - Watershed complexity,
  - Soil and geological character, and
  - Hydrology
- Life cycle study of resident species needed, including the fate of cryptobiotic species and native fish
- More toxicity data needed on species observed in ephemeral streams, particularly data connected to life cycle timing and duration of exposure

WHERE DO WE GO FROM HERE?

Big Picture

AWWQRP USER'S GUIDE – IMPLEMENTATION OF WATER QUALITY STANDARDS

- Arid West Framework
- Arid West Research
- Available and Emerging Regulatory Tools
- Implementing the Regulatory Process
- Water Quality Standards Implementation - Case Studies
- Finding the Best Regulatory Solution



CLASSIC NET ENVIRONMENTAL BENEFIT (NEB) CONCEPT

- Originally presented as a type of Use Attainability Analysis
- 1993 EPA Guidance highlighted in User's Guide
- Continues to be a relevant concept – often indirectly

Steps	Considerations
Step One: Define ecological benefits and detriments	Develop clear definitions of the ecological benefits or detriments that are related to continuing or removing the effluent discharge. The identification of concerns should consider the resource in a broad, watershed context and consider all three of the key elements of the ecosystem, i.e., physical, chemical, and biological elements. Where appropriate, identification of ecological benefits should consider site-specific elements important or even unique to the area in question.
Step Two: Construct a succinct description of the waterbody	Determine how the discharge affects valued water body resources and identify the factor of factors governing how the discharge affects valued water body resources.
Step Three: Develop specific net ecological benefit comparison objectives and define expected performance	Select a reasonable set of ecological benefits and detriments and establish how they will be assessed. To the extent possible, it is recommended that benefits and detriments be quantifiable.
Step Four: Establish testable hypotheses	The null hypotheses states that there is no difference with or without the discharge, while the alternate hypothesis indicates that there is a measurable difference.
Step Five: Collect data and conduct specified analyses	Identify potential sources of existing data; where data gaps exist, collect necessary information.
Step Six: Evaluate net ecological benefit and determine subsequent actions	Evaluation considers all testable hypotheses established in previous steps. Where mitigation of potential detriments is possible, these actions are identified. If mitigation is not possible or detriments are significant, then a finding of no net environmental benefit may be warranted.

NEB CONCEPT MAY BE MANIFESTED IN INTERESTING WAYS

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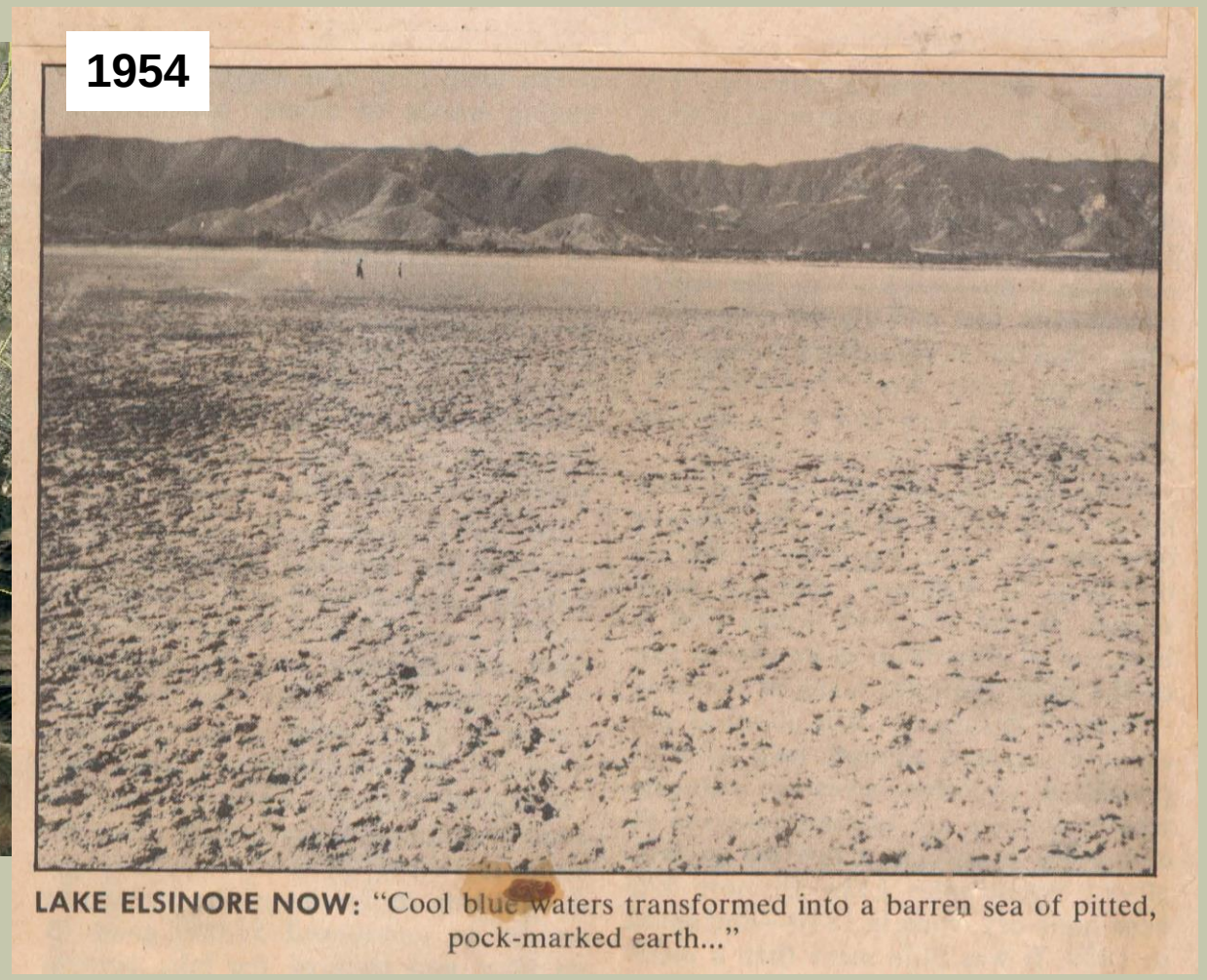
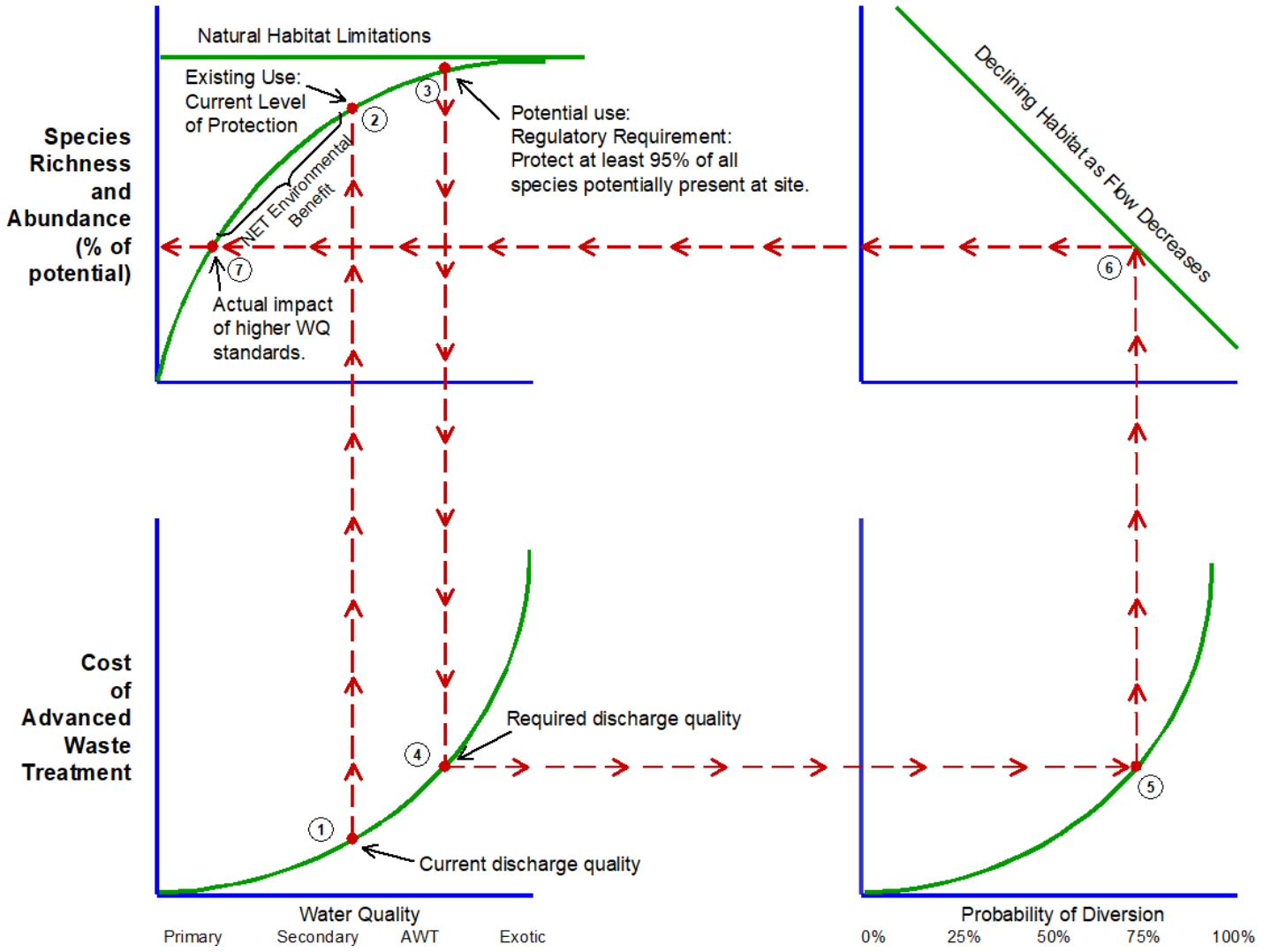
LAKE ELSINORE THEN: "It is to Elsinore Valley what the Alps are to Switzerland, or the desert to Arabia..."



LAKE ELSINORE NOW: "Cool blue waters transformed into a barren sea of pitted, pock-marked earth..."

COMPETING USES & VALUE OF WATER CONTINUE TO DRIVE NEB CONCEPT

- AWWQRP Concept (Habitat Characterization Study 2003)
- Requirement to treat may result in less water in stream
  - Not just a wastewater issue…also an urban runoff capture issue
  - Mill Creek Wetlands and Chris Basin Regional BMPs (Ontario, CA)
    - Limitations on capture of dry weather flow high in bacteria, because minimum instream flow required to protect endangered species



WHAT IS THE HIGHEST ATTAINABLE USE?

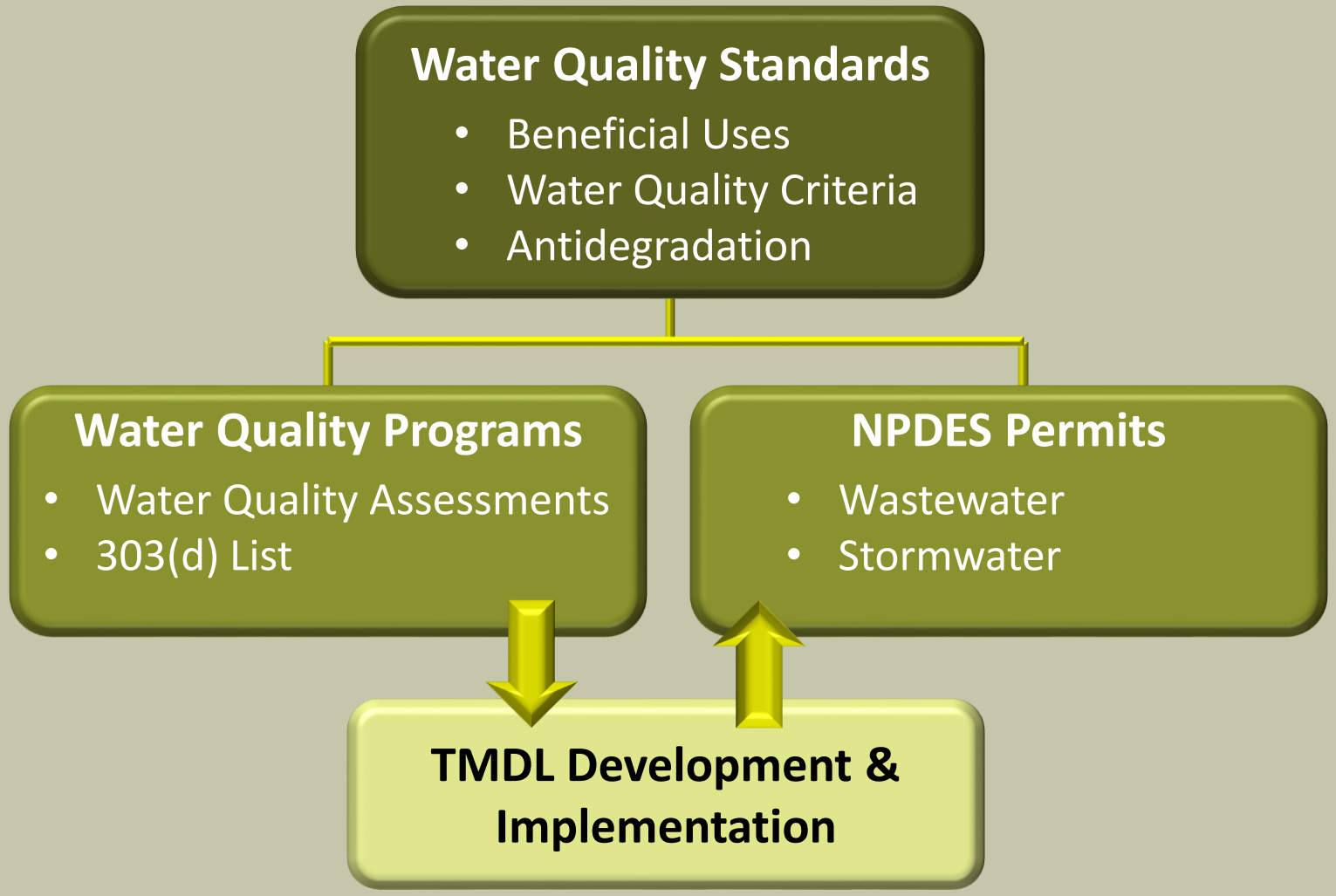
- Water quality standards regulation revised in 2015 to include an important term 40 CFR §131.3(m) – Highest Attainable Use

  …modified aquatic life, wildlife, or recreation use that is both closest to the uses specified in section 101(a)(2) of the Act and attainable, based on the evaluation of the [UAA] factor(s)…There is no required highest attainable use where the State demonstrates the relevant use specified in section 101(a)(2) of the Act and sub-categories of such a use are not attainable.

- *Net Environmental Benefit* concept (including competing uses/values of water) aligns with *Highest Attainable Use* definition (at least conceptually)
- Future research should consider these concepts further

WHERE DO WE GO FROM HERE?

- Future research should consider:
  - The “What”
    - Appropriate uses
    - Relevant water quality criteria
  - The “How”
    - Application to permits
    - Compliance assessment
- Often the “How” is not well developed



WHERE DO WE GO FROM HERE?

Ephemeral Waters – Water Quality Criteria (The “What” – Example #1)

EPHEMERAL WATERS – AQUATIC LIFE CRITERIA

- AWWQRP Studies: limited aquatic community – significant potential for criteria recalculation
  - *Few/no fish*
  - *Few/no planktonic crustaceans*
  - *Perhaps larger influence of terrestrial insects?*
- Likely recolonize/recover quickly
  - *May argue for shorter excursion frequencies*
- Water quality characteristics favor bioavailability-based approaches
  - *Very hard waters, not correlated with alkalinity*
  - *Wastewater effluent will introduce DOC*

EPHEMERAL WATERS CRITERIA – SOLUTIONS?

- Existing solutions
  - *Acute criteria only (e.g., NM and AZ)*
  - *Default criteria recalculation (e.g., AZ)*
    - Metals criteria recalculated without fish and planktonic crustaceans
- Additional research needs for new solutions?
  - *More careful attention to criteria recalculation based on results of ephemeral waters study (e.g., other insects)*
  - *Other species of more recent concern (e.g., mayflies, bivalves, gastropods)*
  - *More careful attention to reduced averaging periods and/or excursion frequencies—will this assist with permit compliance?*

EPHEMERAL WATERS CRITERIA - WOTUS

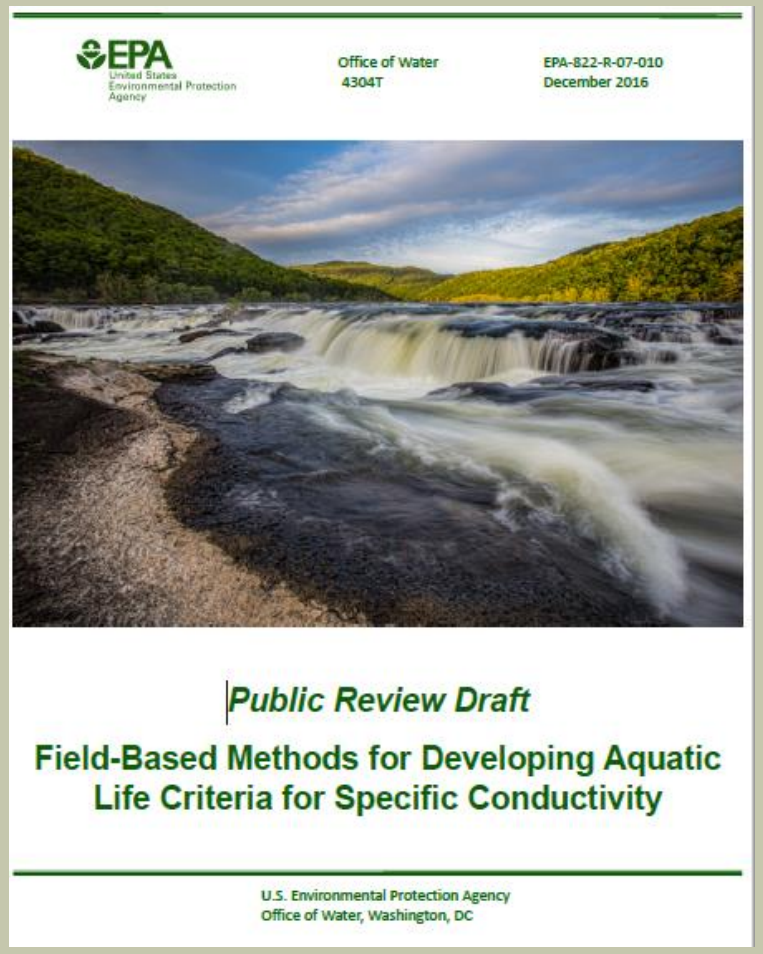
- Waters of the US (WOTUS) rule (2015) – potentially increased focus on regulating ephemeral waters (as tributaries)
  - *Definition of ephemeral waters and making jurisdictional decisions may be particularly challenging in the Arid West*
    - Some regional guidance from ACOE
    - May need additional refinement
  - *Impacts on downstream waters may not be as clear as supposed, specifically with respect to attainment of WQ standards*
  - *If implemented, focus on assigning appropriate and protective criteria to ephemeral waters may grow*

WHERE DO WE GO FROM HERE?

Salts – Water Quality Criteria (The “What” – Example #2)

AQUATIC LIFE CRITERIA FOR DISSOLVED SALTS

- In 2016, EPA proposed a new field-based approach for derivation of aquatic life criteria for dissolved ions
- Uses conductivity as a proxy for dissolved ion concentrations
- Not based on laboratory toxicity studies
- Uses presence/absence patterns of benthic macroinvertebrates



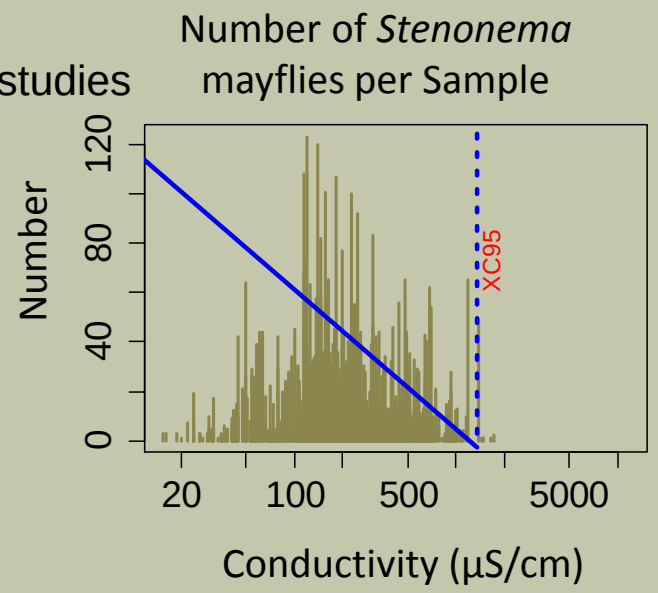
BASIS OF EPA CONDUCTIVITY CRITERIA

Quantifies extirpation of benthic macroinvertebrates vs. conductivity

- *XC95 = conductivity above which a genus is effectively absent (extirpated)*
  - Instead of acute (LC50) or chronic (IC20) response in *controlled* lab studies

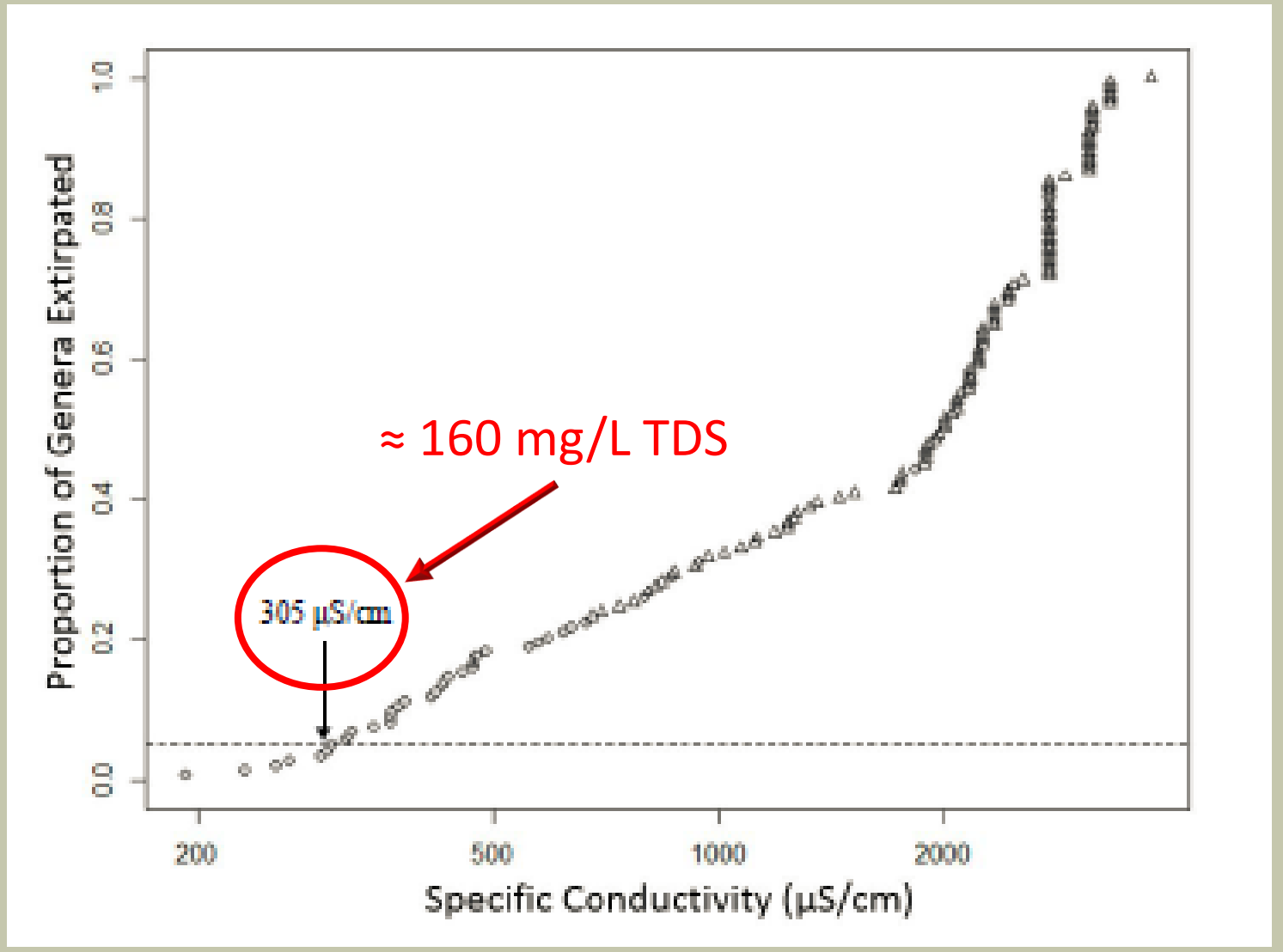
Underlying Assumptions

1. *Absence from sample = absence from site*
2. *Absence from site = extirpation*
3. *Ionic strength is the cause*



BASIS OF EPA CONDUCTIVITY CRITERIA

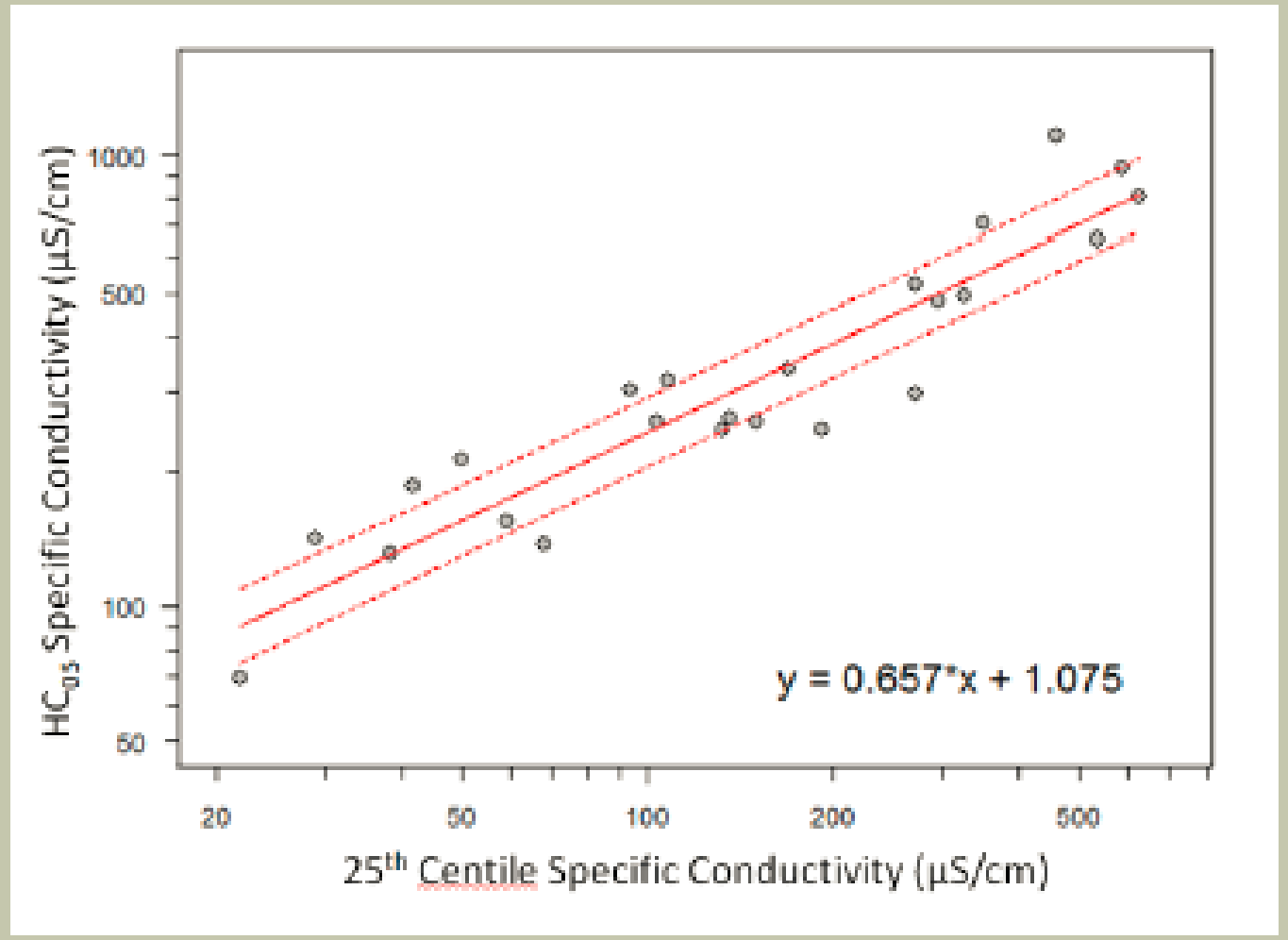
- XC95 values then are ranked by conductivity
- Criteria concentration = 5th percentile of this distribution (chronic)
  - *Acute criterion = 90th percentile of sites meeting the chronic criterion*



BACKGROUND CORRECTION METHOD

- For use where paired macroinvertebrate and conductivity data are not available
- Based on data from 24 ecoregions; *few from Arid West*:

Level III ecoregion		Data source
Number	Name	State data set[a]
15	Northern Rockies	Idaho DEQ
16	Idaho Batholith	Idaho DEQ
17	Middle Rockies	Idaho DEQ
19	Wasatch and Uinta Mountains	Utah DEQ
23	Arizona/New Mexico Mountains	Arizona DEQ



ARID WEST QUESTIONS/CONCERNS

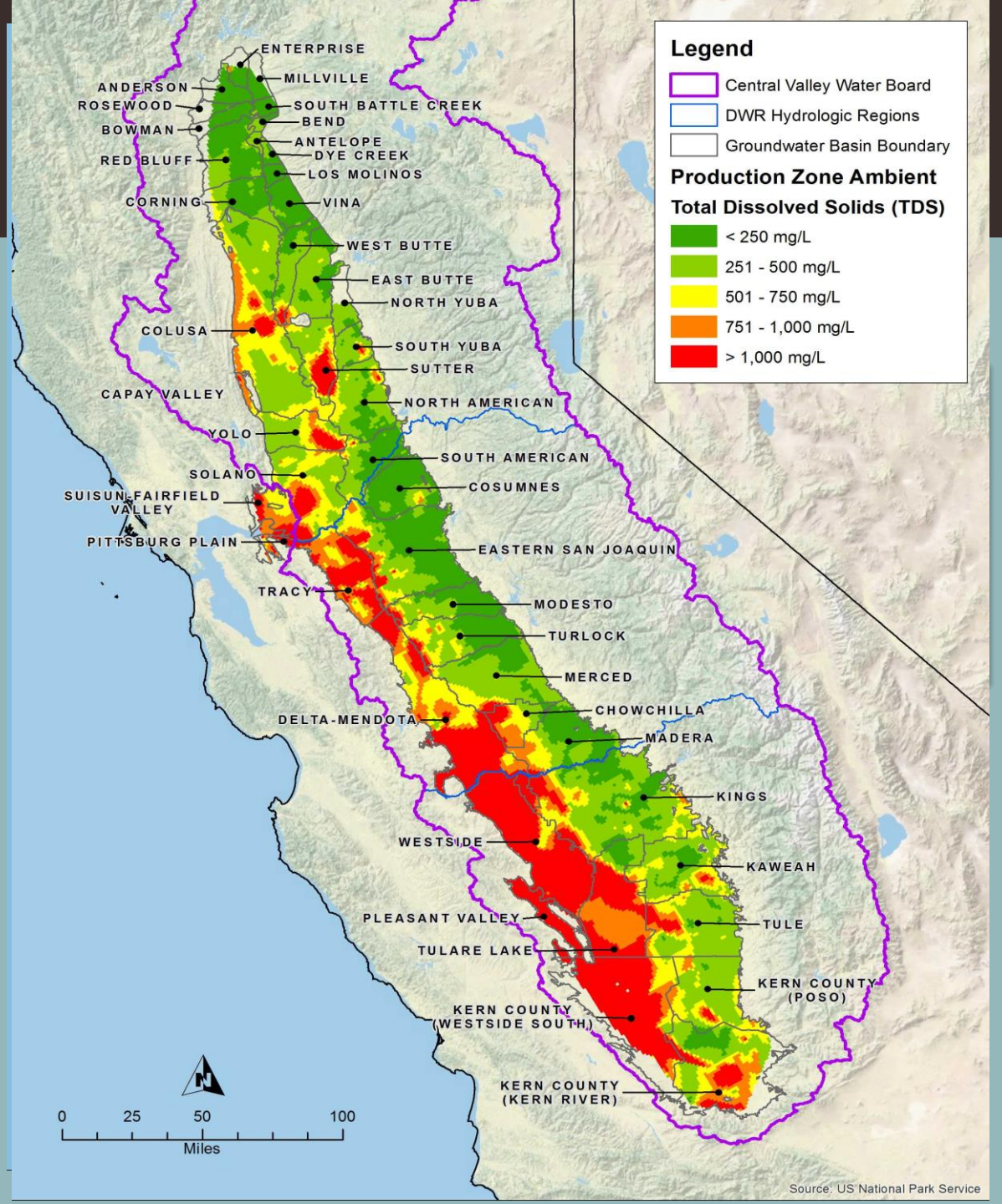
- Does this field-based method apply to waters in the Arid West?
  - *Data sets large enough in Arid West ecoregions mostly from higher elevation, perennial waters*
  - *Therefore, can this method be used in ephemeral (or even effluent-dependent) waters?*
- What about the background-correction method?
- If implemented, such criteria would be difficult to apply, and likely lead to very restrictive concentrations
- Research clearly warranted if this method is to be applied in the region

WHERE DO WE GO FROM HERE?

Central Valley Salinity – Example of Both “What” and “How”

CENTRAL VALLEY SALINITY

- Three hydrologic regions
  - *Sacramento River*
  - *San Joaquin River*
  - *Tulare Lake*
- Annual precipitation declines while annual salt load increases from north to south
- Water quality, especially groundwater, increasingly impacted
- Need for broad-based solutions that consider significant hydrologic differences across the Region



WATER QUALITY REGULATORY DRIVERS

- Beneficial Use Protection Currently Focused On:
  - Municipal/Domestic Water Supply –
    - Secondary Maximum Contaminant Levels (500 mg/L TDS, 900 µS/cm Electrical Conductivity [EC])
  - Agriculture (crops and livestock watering) –
    - Narrative standard translated to protect the most sensitive crop (700 µS/cm EC; ~ 450 mg/L TDS))
- Potential Water Quality Issues on Horizon
  - Aquatic Life Protection

CENTRAL VALLEY SALT CONTROL PROGRAM

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- Program adopted by Region May 31, 2018
  - Effective for groundwater after State Water Board approval
  - Surface water elements effective after EPA approval
- Key Goal: Achieve long-term salt sustainability
- Three-phased Program
  - Phase I: 10-year Prioritization & Optimization Study (P&O Study), estimated cost $7M-$13M
- Concepts of *Highest Attainable Use* and *Net Environmental Benefit* will be inherent to the coming discussion

Phase I P&O Study

- Protection of uses, especially salt-sensitive crops
- Salt management solutions considering varied geography
- Policies/programs that impact salinity
- Conceptual design of local (e.g., salt management areas) and regional (brine line) salt management projects
- Governance structure and long-term funding plan
- Coordination with groundwater management requirements (SGMA)

SUMMARY

Key Takeaway Messages

AWWQRP – AN EFFECTIVE FRAMEWORK

- Much was learned about the aquatic environments in the Arid West
- Tools for criteria modification and implementation have proved useful
- New technical issues would benefit from a similar approach
  - *But be sure to focus not just on the "What", but the "How"*
  - *Implementation of new science is a complicated, multi-stakeholder effort, but can bring results*

ISSUES TO CONSIDER

- Use previous studies to better understand and assign criteria to ephemeral waters
  - *Useful in states with existing ephemeral waters criteria*
  - *If WOTUS rule implemented, additional ephemeral waters might be regulated—what standards should we use, and how should they be implemented?*
- Dissolved salts are a significant technical and regulatory concern
  - *Water quantity management will create water quality challenges*
- Ultimately, both the “what” and the “how” matter

FOR MORE INFORMATION

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- bgensemer@geiconsultants.com

- And thanks to the AWWQRP and WESTCAS!